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PLANKTON REMOVAL TESTS AND POTABLE WATER SURVEY AT NAVAL STATION, ARGENTIA, NEWFOUNDLAND

C. Mervin Palmer, et al

Sanitary Engineering Center
Cincinnati, Ohio

January 1955

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REPORT TO
DEPARTMENT OF THE NAVY
BUREAU OF YARDS AND DOCKS
WASHINGTON 25, D. C.

PLANKTON REMOVAL TESTS AND POTABLE WATER SURVEY AT NAVAL STATION ARGENTIA, NEWFOUNDLAND

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CINCINNATI, OHIO

JANUARY 1955

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REPORT ON
PLANKTON REMOVAL TESTS
AND
POTABLE WATER SURVEY
AT
NAVAL STATION
ARGENTIA, NEWFOUNDLAND
AUGUST 19 TO AUGUST 31, 1954

Details of illustrations in
this document may be better
studied on microfiche

By
C. Mervin Palmer, Biologist
Head of Plankton and Water Supply Unit
and
Hayse H. Black, Senior Sanitary Engineer
Chief, Industrial Wastes Section

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
SANITARY ENGINEERING CENTER
CINCINNATI, OHIO

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SUMMARY

This report pertains primarily to intensive studies conducted at Argentia during the period August 20 to August 31, 1954. It is supported by the results of analyses of weekly water samples from the Argentia Naval Base water supply examined at the Sanitary Engineering Center from May to December 1954. A summary of these observations follows:

1. The number of planktonic algae in the tap water at Argentia Naval Base was consistently lower during the period of this study than was indicated by the Dalecarlia laboratory report dated September 28, 1953. The total algal count ranged from 52 to 2223 per ml in the weekly samples. A maximum count of 4069 per ml was obtained by flushing of fire hydrants August 21, 1954. The three predominant organisms were the diatom, Synedra (during May-June), the pigmented flagellate, Dinobryon (during July) and the diatom, Cyclotella (during August-October).

2. Diatomite filtration was proved effective in removal of algal forms present in the water received at the naval base power station during the period of the test. Satisfactory length of filterruns was demonstrated and with reasonable filter aid economy for the algal concentrations encountered. The filter and auxiliary equipment gave excellent performance.

3. Limited tests on small scale showed efficient removal of algae by coagulation and sedimentation. The need for close control was indicated which is consistent with standard water purification practice. There was strong evidence that these planktonic algae were settling out in the covered storage reservoirs located on the base. This observation warrants further exploration inasmuch as it suggests possible improve-

ment of water quality furnished the power plant by utilizing present facilities.

4. Examination of one set of water samples from the various ponds collected August 24, 1954 showed Clarks Pond to have the highest algal count at that time. Furthermore, the counts were found to be higher in the immediate vicinity of the Clarks Pond pumping station intake than they were in other locations of the same pond. This condition could undoubtedly be improved by extending the intake into deeper water and by providing for the drawing of water from different lake levels. Intermittent application of copper sulphate as an algicide should alleviate this problem.

5. Survey of the naval base water supply from the standpoint of potability consisted of an inspection of the physical facilities at Clarks Pond pumping station and review of available bacteriological and residual chlorine records. Chlorine dosage at the Clarks Pond station varied between 5.90 and 6.98 ppm over a 7 day period in August. This treatment gave a 0.3 ppm residual at the naval base hospital, August 25, 1954. Considering the limited treatment this water receives, it would be advisable to maintain a daily record of chlorine residuals and bacteriological results for tap water on the naval base as evidence of potability.

AUTHORITY

This project was initiated by a letter dated March 1, 1954 from Chief, Bureau of Yards and Docks directed to Surgeon General, Public Health Service. A copy of this communication and subsequent pertinent correspondence are made a part of this report as Appendix A.

OBJECTIVES

Conforming with a request from the Bureau of Yards and Docks, Depart-

ment of the Navy, special studies were conducted of the water supply at the Naval Station, Argentia, Newfoundland. This project was confined to one week for the engineering phase and to twelve days for biological studies. Investigational research was conducted in the following five areas:

1. Identification and counting of plankton
2. Plankton removal by diatomite filtration
3. Plankton removal by use of coagulants
4. Control of plankton at the source
5. Potability of water supply

DESCRIPTION OF WATER SUPPLY

A group of inter-connected lakes serves as the source of water supply for the Argentia Naval Station. These lakes also serve as the source of water for the McAndrews Air Force Base which is adjacent to the naval station. A schematic plan and profile of this system are shown in Figure I.

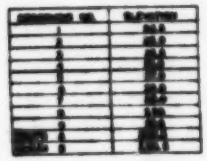
Three pumps take suction from Clarks Pond and discharge to surface covered storage reservoirs designated "A" and "B" which float on the system. Two of these pumps are motor driven and the third, a standby, is powered by a variable speed Waukasha gasoline engine, Model 145 GM. Each pump is rated at 1400 G.P.M. when operating against 43 psi discharge pressure. In addition to reservoirs A and B, there are two elevated tanks and nine surface reservoirs located on the naval base. Three booster stations on the base maintain pressure in the distribution system above a certain level.

Because of the virgin nature of the territory draining into these lakes, they are relatively free of sewage pollution. However, wind action invariably influences turbidity and plankton concentration. The only

FIGURE - 1

SCHEMATIC PLAN AND PROFILE OF FRESH WATER SUPPLY AND DISTRIBUTION SYSTEM

PROFILE



treatment is heavy chlorination at the Clarks Pond pumping station and plain sedimentation which occurs in the various storage reservoirs.

Chlorination was provided at the Clarks Pond pumping station by two automatic chlorinators manufactured by Everson Manufacturing Company, Style PR. These units were designed to feed within a range of 2 to 40 pounds chlorine each per 24 hours. The rate of feed was indicated by a rota-meter. Chlorine drums were set on a scale and the amount of chlorine used each 8 hour shift was determined by difference in weight. Meter records were examined to determine the volume of water currently being pumped. These operation records showed the following pumpage and chlorine dosage for the days indicated:

Date August 1954	Volume of Water Metered at Clarks Pond Pumping Station Gallons	Chlorine Used Pounds	Chlorine Dosage ppm
18	1,136,000	66	6.98
19	1,078,700	61	6.80
20	1,104,800	59	6.41
22	1,086,400	56	6.18
24	1,018,100	50	5.90

It will be noted that the daily pumpage during this period was significantly less than the volume referred to in the July 1948 report prepared by Sheppard T. Powell. This earlier report indicated the need for treating a total of 2.5 M.G.D. whereas the present volume represents only 40 per cent of the 1948 requirements. The meter records checked with pump rating and hours of operation reported. Chlorine dosage likewise seemed high but apparently was necessary to give a satisfactory chlorine residual in the distribution system at the naval base.

IDENTIFICATION AND COUNTING OF PLANKTON

This analytical work was divided into two phases, namely:

(a) Examination of routine tap water samples collected at the Argentia Naval Station power plant and forwarded to the Sanitary Engineering Center, Cincinnati, Ohio.

(b) Analysis of various water samples collected during the period August 20-31, 1954 in connection with intensive studies conducted at Argentia.

The first water sample received from the Argentia system was collected May 14, 1954. Beginning June 11, 1954, weekly samples of tap water were collected at the Argentia Naval Station power plant, preserved with formaldehyde, and forwarded by air express to the Sanitary Engineering Center for plankton analysis. The objective of this work was to provide a record of the types and numbers of plankton developing in the Argentia water supply during the various seasons. Summary of plankton analysis of these weekly water samples, totaling 29, for the period May-December 1954 are tabulated in Table I, Appendix B.

During the period August 20-31, 1954, a total of 101 water samples were collected and analyzed at Argentia. Qualitative analysis only was performed on 13 of these samples. Out of this total of 101 samples, 60 were collected at the Naval Station power plant. The results of these 60 samples are recorded in Table 2, Appendix C. Genera of algae recorded for the Naval Station tap water, Clarke Pond, and the City of St.Johns are recorded in Table 3, Appendix D.

Distribution of the various samples is shown in the following tabulations:

Power Station Tap Water	
a. Prior to August 18, 1954	11
b. August 18-31, 1954	60
c. August 27 to December 24, 1954	18
Filtered Water	11
Coagulated and Settled Water	5
Tap Water other than Power Station	4
Other Ponds in Area	3
Argentia Water Supply Ponds	14*
Boiler Scale	4**
Total	130

* Includes 9 qualitative samples.

** Qualitative Samples.

All analytical work was performed in the laboratory at the Naval Station Infirmary. Plankton analysis was carried out by direct count of organisms visible under magnification of 100X, in 1/13 ml of unconcentrated sample, using a Sedgwick-Rafter counting cell. Modifications of this procedure were made when required. For this work a single unit in the count was considered as an isolated cell (unicellular organism) or a body composed of an integrated group of cells (colony or multicellular organism).

Analyses of the weekly samples of Argentia tap water reveals that the average count for the period from May to December, inclusive, was 689 plankton organisms per ml, with a range from 52 to 2223. High counts tended to appear about four weeks apart indicating that the water in the supply ponds

was probably low in nutrients and incapable of supporting a continuously high plankton growth.

The diatom, Synedra, was the dominant form during May and June. The pigmented flagellate, Dinobryon, was dominant in July, totaling 1841 per ml. on July 16. From August to mid-November, inclusive, the very minute diatom, Cyclotella predominated with a maximum of 1885 per ml. on September 10. Another diatom, Asterionella, was the most abundant form during the last half of November.

A total of 43 genera of algae are reported for the Argentia tap water samples. A number of these were noted only during the intensive period of sampling August 18-31. Included were 10 genera of diatoms, 14 green algae, 6 blue green algae and 13 pigmented flagellates. The comparatively low numbers of blue green algae again indicates a water supply low in nutrients derived from pollution.

With the exception of the periods immediately following flushing of fire hydrants, when the maximum count was 4069, the total counts of planktonic algae were much lower than that for the Dalecarlia laboratory report dated September 28, 1953 which is included in Appendix A.

Samples obtained at four widely separated stations (Power House, Infirmary, B.O.Q., and Navy Exchange) on August 29-30, 1954, would indicate that the plankton count was approximately the same throughout the distribution system. The lower count at the B.O.Q. may be due to the fact that the sample was taken from a tap on the second floor where some settling of organisms could have taken place in the vertical pipe, extending to the second floor. Results for these four samples are recorded below along with two power house samples for comparison.

PLANKTON ANALYSIS OF TAP WATER SAMPLES
FROM FOUR LOCATIONS IN DISTRIBUTION SYSTEM
NAVAL STATION, ARGENTIA, NEWFOUNDLAND
AUGUST 1954

Date	Time	Cyclotella	All Other Algae	Total Algae	Mold Spores	Body Cells	Amorphous Particles	Total Matter
B.O.Q., Second Floor 8/29/54	1:45 PM	16	6	22	8	0	5	35
B.O.Q., Second Floor 8/30/54	6:45 PM	2	4	6	5	0	26	37
Naval Exchange Bldg. 8/30/54	7:15 PM	29	8	37	29	0	14	80
Infirmary 8/30/54	8:15 PM	36	7	43	18	0	23	84
Power House** 8/29/54	2:00 PM	43	5	48	5	0	3	56
Power House** 8/30/54	7:15 PM	38	9	47	20	0	2	69

** These two samples are also reported in Table 2, Appendix C.
Results given in Direct, Strip Counts.
To obtain number per ml, multiply by 13.

On August 31, 1954, boiler #1 at the Power House was opened for inspection after having been put out of service the previous day. Samples of sediment and scale in the cooling pipes were taken from both the top and bottom openings. Microscopic analyses of this material indicated that no algae were present in the sediment nor in the scale. Minute rods resembling bacteria were observed in large numbers. However, when a smear of this material was treated with the bacterial stain, crystal violet, the stain was not absorbed by the particles, indicating that they were probably not bacteria but were inorganic bodies.

PLANKTON REMOVAL BY DIATOMITE FILTRATION

Eleven diatomite filter runs were made during the period August 20 to August 26, 1954, inclusive. Each test run was made with a specific objective. Because of limited time and other considerations some runs were discontinued before shut off pressure was reached.

Plankton analyses were made on the unfiltered and the filtered water for seven of these filter runs. Plankton counts were relatively low in the Naval Station water supply throughout the period of these tests. On three different days, the water being filtered was riled by flushing of fire hydrants in the immediate vicinity of the power plant in an attempt to simulate adverse conditions.

Filter operation data and pertinent information were recorded for each filter run. These results are recorded in tables 4, 5, 6, and 7 which appear in Appendix E of this report. In order to properly interpret the results of each test, each filter run is discussed separately. The diatomaceous earth used was Johns Manville Hyflo Super-Cel.

Equipment

The diatomite filter used for these tests was a pilot model originally built by Wallace & Tiernan Co., Inc. for the Bureau of Yards and Docks. (See photographs). The unit contained ten square feet surface area and was rated at 25 gpm. Modifications were made to permit taking water directly from the distribution system at the Naval Station power plant.

A pressure operated switch was mounted on the base of the filter to control the backwash alarm system. The pressure switch was a disphragm operated single pole, double throw microswitch enclosed in a housing. The control was set to sound the backwash alarm when the effluent pressure dropped to approximately 6 psi. With the exception of this alarm system

the filter conformed to the description given in the W. & T. Instruction Book for "Water Purification Equipment, Frame Mounted, Diatomite Type, 25 G.P.M." Figures 2, 3 and 4 show the filter installation at Argentia.

The slurry feeder assembly was mounted in a separate frame with a six gallon hopper. Power to drive the slurry feeder was supplied by a 1/6 horsepower split phase, 110 volt, 60 cycle motor with belt drive. Description of this slurry feeder is given in Section 4 of the W. & T. Instruction Book previously referred to. The precoat pot and alarm system were mounted on a panel on the slurry feeder hopper. This arrangement permitted applying the diatomite precoat to the filter septums using water from the distribution system without recirculation of the precoat slurry.

The slurry hopper was an inverted cone frustum. The hopper was calibrated to facilitate determining the volume of slurry fed. This hopper held six gallons of liquid when the water level was 2 1/2 inches below the top of the hopper. The volume of slurry remaining in the hopper could be readily determined by reference to the calibration curve, figure 5.

The reducing valve assembly and necessary fittings were an integral part of this equipment. This was connected into the power plant water supply line and the reducing valve adjusted to give approximately 35 psi for filter operation. Water gauge readings for line pressure and reduced pressure are recorded in table

Slurry Feed

The filter was operated with two body feed slurry concentrations. A slurry concentration of 1.965 pounds filter aid per gallon was used for filter runs 2, 3, 4, 4a and 5. This concentration was reduced to 1.5 pounds per

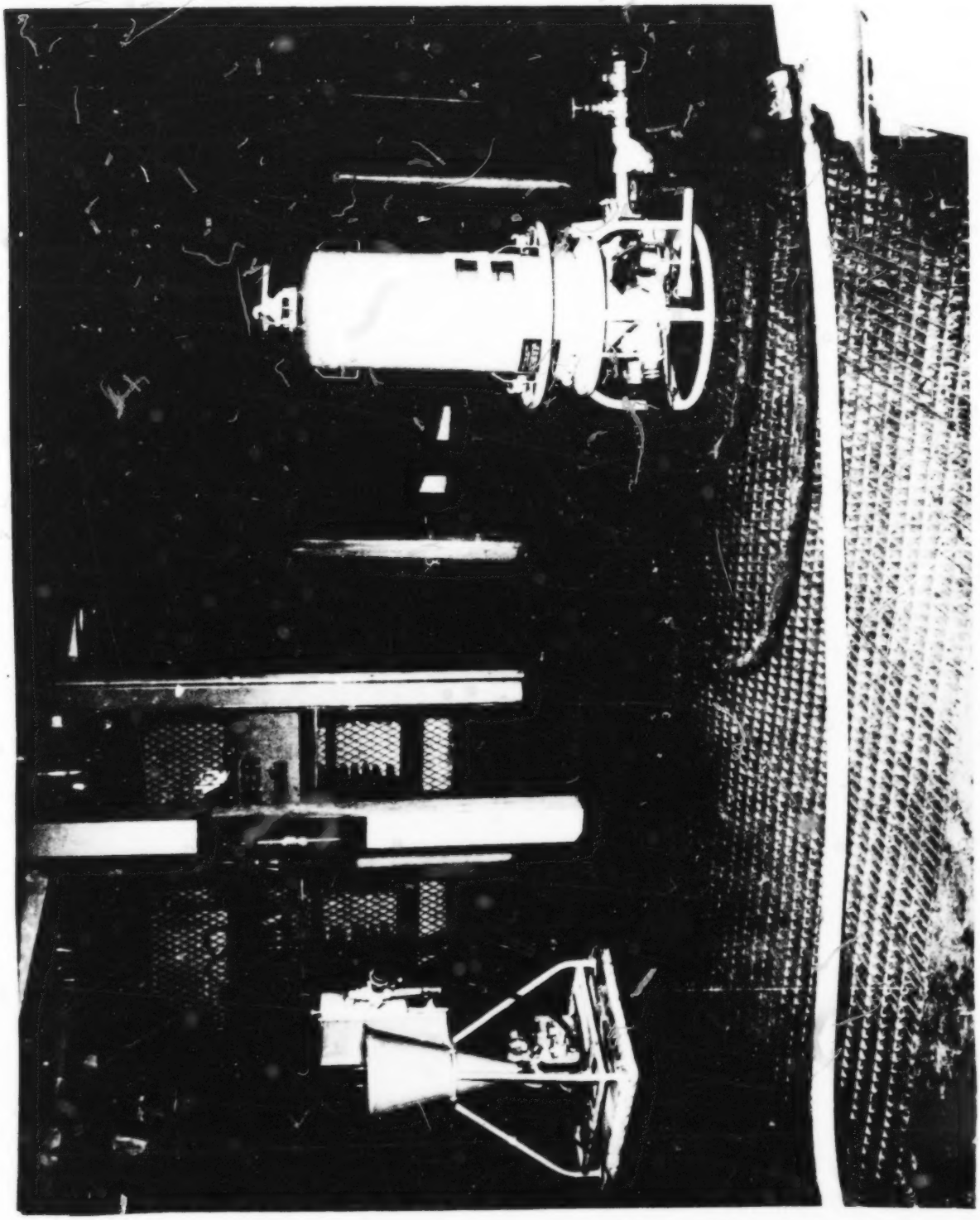


Figure 2 - Filter Installation
Argentia Power House

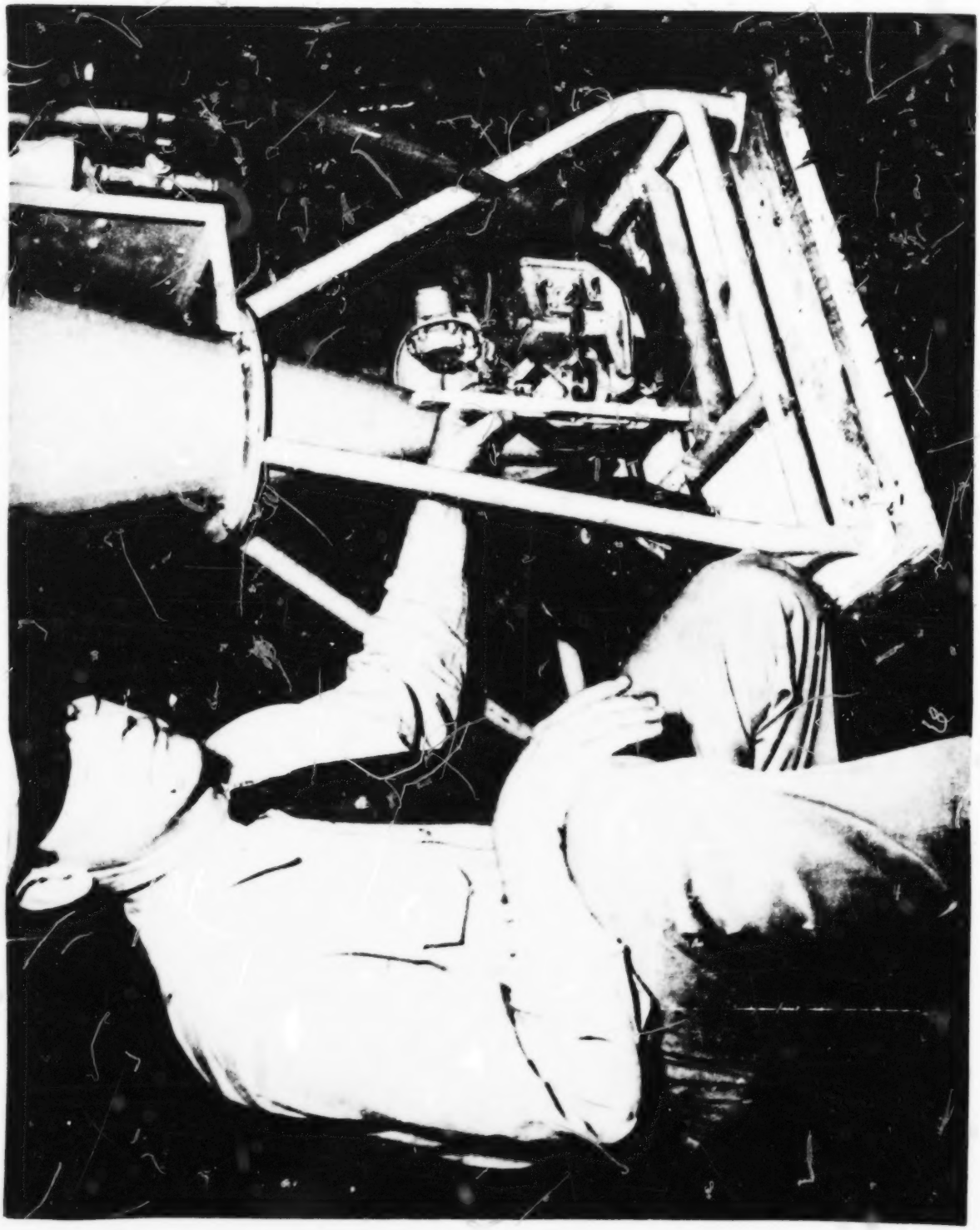


Figure 3 - Slurry Feeder Ch.Mach.Part6

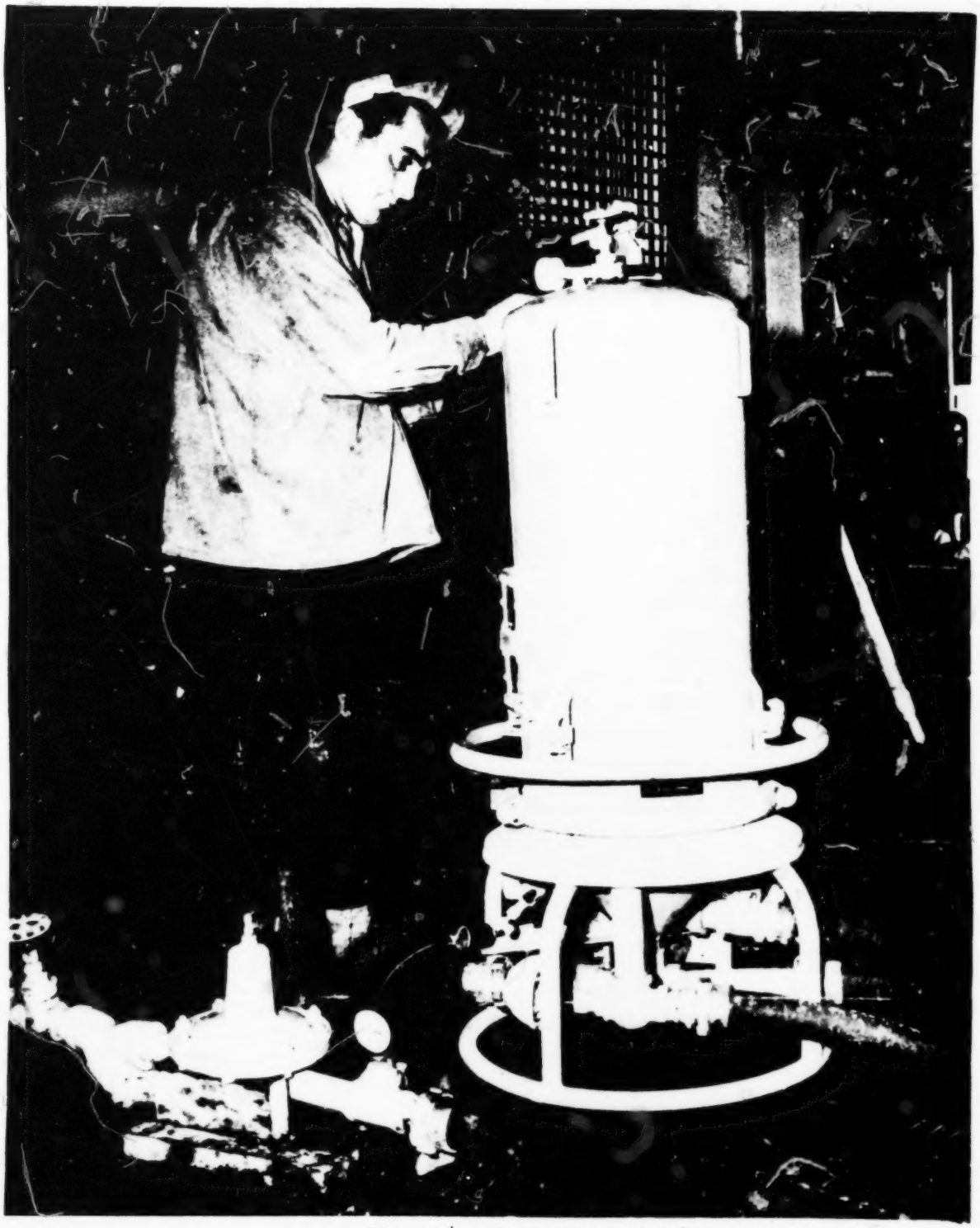


Figure 4 - Asst. Fitzpatrick
Reading Filter Gauges

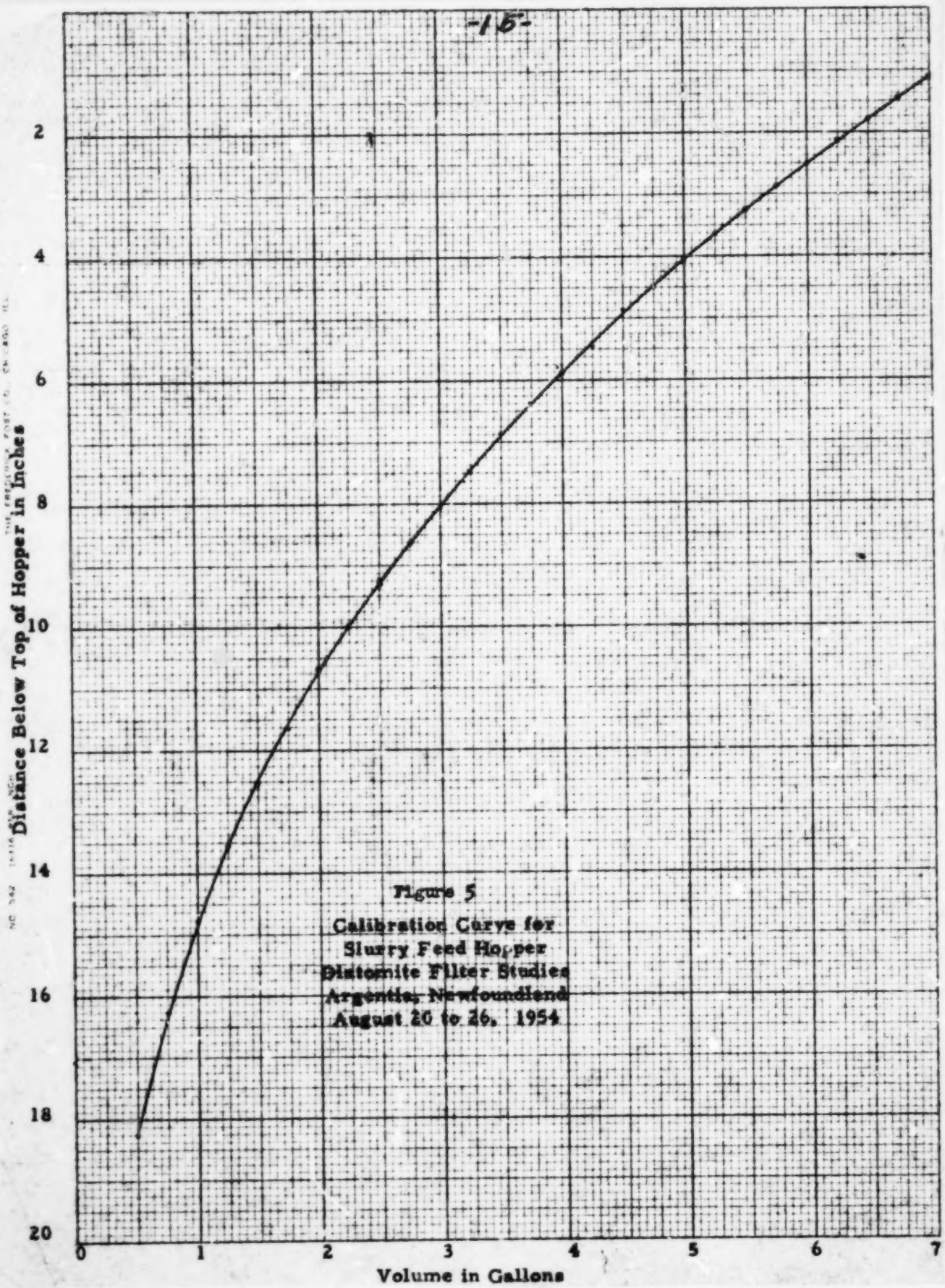


Figure 5

Calibration Curve for
Slurry Feed Hopper
Diatomite Filter Studies
Argentia, Newfoundland
August 20 to 26, 1954

gallon for filter runs 6, 7, 8, 9, and 10. If time had permitted further testing, the slurry concentration would have been reduced still more.

The rate of body feed ranged from dial setting No.6 to less than No.2. The volume of slurry withdrawn from the hopper for each run was determined. Computations for rate of body feed in gph (gallons per hour) for filter runs Nos. 2, 3, and 4 showed consistently lower values than was anticipated from the W. & T. Instruction Manual, Section 4-5. The actual discharge compared favorably with the rated discharge at the higher body feed dial setting. The following tabulation compares the determined pump discharge with the rated discharge for four filter runs:

Run No.	Body Feed Dial Setting	Manual Rating (gph)	Actual Discharge (gph)
2	2	0.33	0.136
3	2	0.33	0.133
4	4	0.66	0.484
4 (a)	6	0.99	0.94

When the body feed dial was set less than 2, clean water leaked back through the pump into the slurry hopper. The dial setting less than 2 was below the operation range for which this diaphragm pump was designed. This observation is described in more detail in the discussion for the filter runs where this leak back occurred.

The rate of body feed for a given dial setting appeared to be a function of the slurry concentration. This condition was noted for two runs using dial setting No.3 but a different slurry concentration for each one. The slurry having 1.5 pounds filter aid per gallon was fed at a rate 33.8% higher than the slurry consisting of 1.965 pounds filter aid per gallon.

Periods of Operation

During this seven day period of the test, the filter was in operation 81 hours and 45 minutes. The dates and corresponding hours of operation are recorded below:

Filter Run	Day	Date	Hours
Installation	Thursday	August 19	2 PM - 6 PM
1	Friday	August 20	9:20 AM - 10:30 AM
2	Friday	August 20	11:00 AM - 9:20 PM
3	Saturday	August 21	9:25 AM - 12:15 PM
4	Saturday	August 21	12:25 PM - 6:10 PM
4a	Saturday	August 21	8:00 PM - 8:30 PM
5	Sunday	August 22	1:35 PM - 6:00 PM
6	Monday	August 23	9:35 AM - 8:35 PM
7	Tuesday	August 24	8:45 AM - 9:45 PM
8	Wednesday	August 25	8:35 AM - 10:35 PM
9	Wednesday	August 25	11:55 PM
	Thursday	August 26	8:20 AM
10	Thursday	August 26	9:55 AM - 8:45 PM

Filter Run No. 1 (Duration 1 hr. - 10 min.)
Run terminated when effluent pressure reached 7.5 psi
Economy 1890 gallons per pound filter aid

This run was made employing one pound of precoat and no body feed. The test was intended to give results for a minimum of filter aid applied. The run was short as expected, demonstrating the value of and need for body feed.

Samples for plankton analyses were collected immediately before and dur-

ing the test. The quality of the water being filtered is indicated by these results. Data are reported as quantities per ml.

Time	Total Algae	Total Matter
8:45 AM	1014	1144
9:45 AM	806	962
Average	910	1053

A sample of filtered water collected at 9:45 AM contained 26 algae and 351 total matter per ml. These results indicate incomplete coverage of the filter septa which would have been corrected with body feed.

Filter Run No.2 (Duration 10 hrs. 20 min.)
Run terminated when effluent pressure reached 16 psi
Economy 4600 gallons per pound filter aid
Body feed dial setting 2

This test was satisfactory from the standpoint of filter aid economy and length of run. However, the water being filtered had a low plankton count. The run was terminated because it appeared that shut off pressure would be reached before morning. Results of unfiltered samples follow:

Time	Total Algae	Total Matter
12:45 PM	611	741
3:45 PM	351	507
9:15 PM	520	624
Average	494	624

Filtered water samples collected at 12:45 PM and 3:45 PM showed the absence of algae. Total matter in the first filtered water sample was 117 and in the second sample 585 per ml.

The filter aid economy for this run would probably have been increased if the test had been continued to shut off pressure.

Run No. 3 (Duration 2 hrs. 50 min.)
Run terminated when effluent pressure reached 5 psi
Economy 2700 gallons per pound filter aid
Body feed dial setting 2

Slurry from Filter Run No. 2 was allowed to remain in the hopper over night. In the interim, 0.344 gallon of water leaked back through the slurry feeder into the hopper. This dilution represented 6.65 per cent increase. Inasmuch as filter aid used for Run No. 3 was computed on a volume basis, there was no error introduced because of this dilution. Following this experience, slurry was removed from the slurry hopper at the end of each day's experiments. It is desired to record that the air agitation provided satisfactory mixing in a relatively short period when the slurry was quiescent for several hours, even over night.

Because of the relatively low algal counts for the preceding filter run, it was decided to rile the water in the distribution system by flushing fire hydrants in the immediate vicinity of the power plant. Accordingly an 8 inch and a 12 inch line were flushed simultaneously for 20 minutes immediately prior to starting Run No. 3. This resulted in a substantial increase in the number of algae and a corresponding short filter run indicating need for a higher rate of body feed. Algae and total matter determined for 5 raw water samples during this filter run are tabulated below:

Time	Total Algae	Total Matter
9:30 A.M.	2886	3692
9:45 A.M.	4069	5759
10:00 A.M.	2665	3432

Continued

Time	Total Algae	Total Matter
10:15 A.M.	2288	2795
12:15 P.M.	1651	1833
Average	2712	3502

Analysis of filtered water samples collected at 9:45 A.M. and 12:15 P.M. showed complete removal of algae. The first sample contained 65 particles of total matter per ml. and the 12:15 P.M. sample showed 26 for total matter.

During this test, samples were collected on a 15 minute basis between 9:25 A.M. and 11:25 A.M., inclusive, for visual check of turbidity. Boiler feed water glass test tubes were used for this purpose. Turbidity could not be detected in the filtered water.

Filter Run No. 4 (Duration 5 hrs. 45 min.)
Run terminated when effluent pressure reached 21 psi
Economy 1580 gallons per pound filter aid
Body feed dial setting 4

The rate of body feed was increased for this run anticipating plankton counts continuing at about the same level as existed at the end of the preceding filter run. The body feed dial was advanced to 4, whereas this dial setting was 2 during Run No. 3. It will be noted in Table 4 that this change increased the slurry feed rate from 0.133 to 0.484 gallon per hour or 3.64 times.

Inasmuch as there was no further flushing of hydrants on this date, the water in the distribution system cleared markedly during the afternoon. Analysis of two unfiltered water samples show this improvement in the following tabulations:

Time	Total Algae	Total Matter
12:30 P.M.	1193	2028
5:30 P.M.	468	559
Average	826	1294

There were no filtered water samples collected during this run. The filter run was terminated when the filter cake on the elements built up to where it was in contact at the closest points. This was much too generous body feed.

Filter Run No. 4a (Duration 30 minutes)
Economy 890 gallons per pound filter aid
Body feed dial setting 6

Filter Run No. 4a was made for the sole purpose of determining the rate of body feed with the control dial set on 6. During this 30 minute run, the feeder fed 0.47 gallon of slurry, giving a rate of 0.94 gallon per hour. This approached very closely the manufacturer's rating for the diaphragm pump as given in a previous section designated "Slurry Feed." Converting to a weight basis, this feed represented 1.85 pounds filter aid per hour.

Filter Run No. 5 (Duration 4 hrs. 25 min.)
Run terminated when effluent pressure reached 26 psi
Economy 2060 gallons per pound filter aid
Body feed dial setting 3

Filtration results up to this time indicated that a body feed dial setting between 2 and 4 should be optimum when the water contained significant numbers of plankton. Accordingly, this run was made with the feed control dial set at 3 even though the plankton count was known to be low. This setting gave a body feed rate of 0.32 g.p.h. The quality of water being filtered is shown by the following results:

Time	Total Algae	Total Matter
9:30 A.M.	416	663
2:00 P.M.	338	533
Average	377	598

There were no filtered water samples collected during this run.

During the 4 hours and 25 minutes filter operation, the drop in pressure across the filter was 5-1/2 pounds. If this pressure differential had continued to increase at the same rate, this filter run would have lasted approximately 16 hours. Considering the effect of the one pound of precoat on filter aid economy for short filter runs, it is reasonable to expect that economy for this run would have been improved if the run had been allowed to continue to shut off pressure.

Filter Run No.6 (Duration 11 hrs. 0 min.)
Run terminated when effluent pressure reached 6 psi
Economy 2250 gallons per pound filter aid
Body feed dial setting 3

This was the first filter run using a slurry concentration of 1.5 pounds filter aid per gallon. A new batch of slurry was prepared for this run and each subsequent run.

The effect of flushing fire hydrants on the total algae in the water being filtered was demonstrated during Filter Run No.3. Based on what had been learned to date and considering the less concentrated slurry, it was decided to leave the body feed dial setting on No.3, the same as for Run No.5. This proved to be a fairly good run even though the less concentrated slurry was found to feed at a 33.8 per cent higher rate at the same (No.3) dial setting.

Prior to starting this filter run, the hydrants were again flushed for 10 minutes beginning at 9:15 A.M. The water in the distribution system remained

riled through the forenoon but cleared appreciably in the afternoon. This is shown by the following results for samples of unfiltered water:

Time	Total Algae	Total Matter
8:15 A.M.	546	1326
9:45 A.M.	2015	3523
10:00 A.M.	1664	2808
10:15 A.M.	1807	2483
10:30 A.M.	1716	2041
10:45 A.M.	1716	2496
11:00 A.M.	2015	2379
11:15 A.M.	2470	3263
12 Noon	1593	1898
3:00 P.M.	325	520
5:00 P.M.	442	498
8:10 P.M.	598	923
Average First 4 Hours	1874	2612
Average Next 7 Hours	455	647

Two filtered water samples were collected during Run No.6. The results of analysis for these samples are tabulated below:

Time	Total Algae	Total Matter
10:15 A.M.	0	117
8:10 P.M.	0	65

During the first 4 hours filter operation, the pressure drop averaged 3 pounds per square inch each hour. Shortly thereafter the water in the dis-

tribution system contained fewer algae which condition was reflected in the filter operation. The algal counts indicate that the hydrants should have been flushed again at noon. This should have given a more uniform water and a slightly reduced filter aid economy by virtue of a shorter filter run. Considering the first 4 hours operation, it appears that the body feed was optimum for the water being filtered. It is doubtful if a much higher filter aid economy could have been reached for that particular water.

Filter Run No.7 (Duration 13 hrs. 0 min.)
Run terminated when effluent pressure reached 8.5 psi
Economy 3390 gallons per pound filter aid
Body feed dial setting 2.5

Anticipating cleaner water with repeated flushing of the distribution system and in the interest of improving filter aid economy, it was decided to reduce still further the amount of body feed. Accordingly, the dial control was set on 2.5 for this filter run.

Fire hydrants were flushed for approximately 10 minutes during each of 4 periods on this date. The time for the beginning of each flush is recorded below:

8:50 A.M.

10:35 A.M.

12:35 P.M.

2:55 P.M.

Two hydrants were flushed during the first and second periods and three were flushed thereafter. At 10:35 A.M. the west hydrant was opened wide causing some flooding of the street and material near by. The riling effect on the water in the distribution system was much less pronounced than it was following flushing on Saturday and on Monday. This (Tuesday) was the last day that hydrants were flushed.

Except for a few minutes following the first two flushings, the water being filtered contained fewer plankton than it did on Saturday and Monday. This condition was reflected in the 13 hour filter run which was terminated shortly before shut-off pressure was reached. Results for a series of unfiltered water samples are tabulated herewith.

Time	Total Algae	Total Matter
8:15 A.M.	481	793
8:45 A.M.	689	715
9:25 A.M.	962	1261
10:30 A.M.	962	1092
10:45 A.M.	2574	2782
11:00 A.M.	[illegible]15	2353
11:45 A.M.	1014	1365
12:30 P.M.	0	182
1:10 P.M.	208	403
1:30 P.M.	13	78
2:00 P.M.	13	91
2:50 P.M.	0	143
3:15 P.M.	546	[illegible]
5:00 P.M.	0	286
9:30 P.M.	832	1066
Average	687	929

Filtered water samples showed the following results:

10:45 A.M.	13	546
2:30 P.M.	0	247

The body feed dial setting of 2.5 gave a feed rate of 0.275 g.p.h. This

was substantially below the manufacturer's rating fo the slurry feeder at this setting. Filter aid economy was improved as expected.

Filter Run No.8 (Duration 14 hrs. 0 min.)
Run terminated when effluent pressure reached 8 psi
Economy 6115 gallons per pound filter aid
Body feed dial setting <2

Operation data accumulated to date and the relatively low plankton counts in the water being filtered made it clear that the body feed could be reduced still further. Having reduced the slurry concentration once, it was decided to cut back the rate of feed control to a dial setting a little less than 2. This dial setting was below the operation range for which this diaphragm pump was designed. However, the slurry feeder appeared to function properly at this low setting as viewed through the plastic housing.

Based on previous filter runs, it was estimated that this slurry feeder control setting less than 2 would feed approximately 0.1 g.p.h. of body feed. However, this restricted operation of the diaphragm pump allowed clean water to leak back through the pump into the slurry hopper. By actual measurement, the slurry volume was decreased only 0.1875 gallon in the 14 hours of filter run.

The amount of filter aid used during filter Run No.8 was determined by difference. The remaining slurry at the end of the run was siphoned from the slurry hopper and allowed to settle over night. The supernatant was decanted off the next morning and the sludge cake was weighed. A sample of the wet sludge was dried and found to contain 73.5 per cent moisture. This filter run used 2.73 pounds of filter aid as body feed. Adding the one pound of pre-coat, the economy for this run amounted to 6115 gallons of water filtered per pound of filter aid.

Ten samples of unfiltered water were analyzed during this filter run.

The results are recorded below:

Time	Total Algae	Total Matter
8:15 A.M.	949	1131
8:50 A.M.	910	1157
10:30 A.M.	702	1131
11:30 A.M.	715	1183
12:30 P.M.	442	910
1:10 P.M.	13	169
1:30 P.M.	559	936
2:30 P.M.	819	1248
3:30 P.M.	1014	1417
4:30 P.M.	871	1066
Average	699	1035

One sample of filtered water collected at 10:30 P.M. showed complete absence of algae and 169 total matter per ml.

This test gave unusually high filter aid economy. This resulted from the reduced body feed and the relatively clean water being filtered.

Filter Run No.9 (Duration 8 hrs. 25 min.)
Run terminated when effluent pressure reached 16.5 psi
Economy 5190 gallons per pound filter aid
Body feed dial setting less than 2

The installation and operation instructions for this diatomite filter, prepared by Wallace & Tiernan Company, Inc., specified that the reducing valve should be set so that the downstream pressure would be 35 psi. Reference to the tabulated water gage readings (Table 6) for the first 8 filter runs reveals that the reduced pressure was generally between 35 and 37 psi. However, during Run No.7 when the line pressure went up to 90 psi, the reduced pressure

advanced to 39 psi.

The setting of the reducing valve was changed for filter Run No.9 to give a downstream pressure of 30 psi. This adjustment was made with the thought that leak-back through the diaphragm pump into the slurry hopper might be eliminated even though the dial setting was held at less than 2, the same as the preceding run. It was found that leak-back continued even at the reduced pressure. During this filter run of 8 hours and 25 minutes, the leak-back into the slurry hopper exceeded the slurry pumped by 0.375 gallon. At the beginning of the filter run the slurry hopper contained 6 gallons of slurry and at the end of the run the volume had increased to 6-3/8 gallons. Based on filter Run No.8, we used 2.64 pounds of filter aid during Run No.9 giving an economy of 5190 gallons filtered water per pound of filter aid.

This reduced pressure gave a top filter pressure varying between 24.5 and 25 psi. The filter effluent pressure was 24 psi at the beginning of the run and 16.5 psi when the run was terminated 8 hours and 25 minutes later. A sample of unfiltered water collected just prior to termination of this filter run showed the following analysis:

Time	Total Algae	Total Matter
8:15 A.M.	767	1170

There were no filtered water samples collected for analysis during this filter run but the filter was apparently performing satisfactorily.

Filter Run No.10 (Duration 10 hrs. 50 min.)
Run terminated when effluent pressure reached 23 psi
Body feed dial setting 2

The reducing valve was readjusted prior to this run to give 35 psi downstream pressure with a line pressure of 60 psi. The body feed dial setting

was moved up to 2 again. The body feed pump appeared to be functioning normally at the beginning of the filter run. There was no evidence of clogging.

One sample of unfiltered water on this date showed the following results:

Time	Total Algae	Total Matter
3:00 P.M.	715	975

A sample of filtered water collected at the same time showed a count of 13 algae and 182 total matter per ml.

This run was continued through the day even though the writer departed for the United States at 2:00 P.M. prior to its completion. Information on filter aid usage was not recorded but the 10 hours and 50 minutes filter run indicated satisfactory unit operation.

Filtered Water Temperatures

During this seven day test period, seven readings were taken of the filtered water temperature. The temperature was 64° F. for each reading, except the one taken at 10:00 A.M., August 20, when the reading was recorded as 62° F.

Filter Aid Economy

The gallons of water filtered per pound of filter aid for each run are recorded in tables 4 and 5. The most striking results were accomplished by filter Run No.8 which gave an economy of 6115 gallons per pound of filter aid. However, the algae count for this test was low averaging only 699 per ml.

The effects of higher algae counts on filter aid economy and length of filter run were illustrated by filter Run No.3. For this test the total algae count averaged 2712 per ml. The economy dropped to 2700 gallons per pound of filter aid and the run was reduced to 2 hours and 50 minutes. The need for

increasing body feed was indicated.

During the first 4 hours of Run No.6, when the algal count averaged 1874 per ml., the economy was 1845 gallons. If the same quality of water had been maintained for an 8 hour period, the economy should have increased to 2145 gallons per pound of filter aid.

It will be appreciated that additional filtration data should be obtained as basis for design. The observations made indicate that the filter tested should be capable of the following performance under the stated conditions:

Raw water turbidity..... None detectable

Raw water total algae ..... 2000 per ml.

Raw water total matter ..... 2500 per ml.

Filter aid economy ..... 2000 gallons per pound

Water filtered in 8 hours .....12000 gallons

Length of filter run ..... 8 hours

Plankton Removal by Filtration

Because of the varying plankton content of the water as received at the Naval Station, it was deemed advisable to obtain as much data as possible during the period of test. A total of 60 tap water samples were analyzed at Argentia during the period August 20 to August 31, inclusive. During this same period, eleven filtered water samples were collected and examined. The results of these observations are recorded in tables No. 2 and No. 8 in the Appendices.

The concentration of plankton algae in the unfiltered water in the distribution system, based on the 60 samples, varied from a maximum of 4069 to a minimum of zero with an average of 978 per ml. The higher values followed

flushing of the fire hydrants. Considering the results for samples of unfiltered water which were collected simultaneously with the filtered water samples, the average plankton count in the unfiltered water was 1157 per ml. The filtered water was virtually free of plankton. Disregarding the first filter run when only precoat was applied, the filtered water was free of cyclotella, the predominant algal form. Only one small alga was observed in each of two of the filtered water samples when body feed was used as is normal practice. The multiplier of 13 causes these results to be recorded as 13 plankton per ml. for these two samples. In all other filtered water samples the plankton count was zero.

Certain amorphous particles were found to be present in every sample of filtered water and approximated in numbers the particles present in unfiltered water, although the particle size in the former was much less than in the latter. It is probable that the particles in the water were screened out by the filter, but, at the same time, additional minute particles from the outer surface of the filter were released into the filtered water.

PLANKTON REMOVAL BY USE OF COAGULANTS

Algae constitute a universal problem in water purification. It is not uncommon for algae to pass through coagulation basins in sufficient numbers to reduce significantly the length of filter runs even in the most modern water treatment plants. Because of this recognized condition, some exploratory work was performed at Argentia to determine the efficacy of plankton removal by coagulation and sedimentation.

Tests were made using 25 gallons of water in the diatomite filter precoat drum. Alum and lime were the coagulants used. A total of five tests were made, each with a different chemical dosage. Following addition of chem-

icals, the water was stirred gently with a paddle for 20 minutes. Samples of the treated water were collected one foot below the water surface after a 1 hour and 40 minute quiescent period. The results of this work are recorded in table 9. A more complete analysis of both the raw and treated water is given in table 10 of the Appendices. It will be noted that 3 of the 5 tests gave efficient plankton removal. When a chemical dosage was employed to give good floc formation, satisfactory algae removal was accomplished. Amorphous particles in the water were increased by coagulation probably due to presence of minute coagulated particles which had not settled out in the period allowed.

Sedimentation in the reservoirs appeared to be effective in removal of algae as well as turbidity as indicated by very low counts on Tuesday, August 24. This was the third day fire hydrants were flushed in the vicinity of the power plant giving a relatively clean distribution system and water primarily from storage reservoirs.

CONTROL OF PLANKTON AT THE SOURCE

Samples of surface water were obtained by helicopter from the approximate center of the five ponds which constitute the water sources for Argentia and from Larkins Pond. Four of these ponds are in series with the outflow of one entering the one next lower in elevation as indicated in Figure 1.

Plankton organisms were more abundant in Clarks Pond from which the Argentia water supply is obtained than they were in the other ponds. Gull, Kidney, Barron, and Argentia Ponds all had plankton concentrations less than half that of Clarks Pond. In fact, Gull Pond had only 65 organisms per ml as compared to 312 per ml for Clarks Pond. The concentration of the diatom, Cyclotella, in Gull, Kidney, and Barron Ponds was less than one twentieth

that in Clarks Pond (Table 11).

Three other water sources in southern Newfoundland were analysed for comparison. Larkins Pond which is adjacent to Clarks Pond had a plankton count approximating that of Clarks. A pond 20 miles east of Argentia had a count of 91 organisms per ml. A tap water sample from the city of St. Johns had 52 organisms per ml. Thus, of eight supplies tested, Clarks Pond from which the Argentia water supply is obtained, had the highest plankton count.

Additional samples from five locations in Clarks Pond indicated that the number of organisms was much higher at and near the Argentia water supply intake than at the other sampling points. This is probably due to the fact that the intake pipe is located along the windward side of the pond where surface plankton would tend to be concentrated by the wind. The number of plankters at the center of the pond, at the shore line near the pumping station, and in the intake well at the screens are shown in Table 12.

The present intake is located in shallow water. Water near the surface commonly contains a larger number of plankton than that a few feet below the surface. Furthermore, the water at the intake would include a considerable number of organisms from the bottom of the pond whenever wave action was sufficient to stir up bottom deposits. These conditions may explain, in part, the higher counts for the intake water.

A water supply for Argentia containing a smaller amount of plankton could undoubtedly be obtained by relocating the water supply intake. By placing it at a point where surface and bottom organisms would not be drawn into the supply and where the pond water contained a low concentration of true plankton, a very significant reduction in the number of algae and re-

lated organisms in the water supply should result. An extension of the present inlet pipe farther and deeper into the pond with optimal openings at several depths should accomplish this. Providing the low algal counts in the samples from the ponds located at higher elevations were typical, it appears that a superior water could be obtained by bypassing Clarks Pond.

The use of an algicide such as copper sulfate would be another method for obtaining water with low plankton numbers. Dinobryon and some of the other organisms which have been recorded are potential taste and odor producers. Copper sulfate at the rate of up to 8.3 pounds per million gallons of water has been used in many American water supplies for the control of plankton. Care must always be taken to prevent fish kills or tastes and odors from dead plankton when algicides are used.

Chlorine is an effective algicide and the chlorine treatment of the water at the pumping station was sufficiently high to kill all algae. The algae recorded for the tap water were in all probability dead organisms and would tend to settle out in a comparatively short time if the water were permitted to remain quiescent in an underground reservoir before it entered the distribution system. This might explain the apparent low algal counts during and following flushing of the fire hydrants when the booster pumps were operating.

POTABILITY OF WATER SUPPLY

Survey of the Naval Base water supply from the standpoint of potability consisted of:

(a) Inspection of physical facilities at Clarks Pond pumping station

(b) Review of chlorination and water pumpage records

(c) Testing for residual chlorine and review of records

(d) Examination of available bacteriological results

(e) Observations August 20-31, 1954

Discussion of Items (a) and (b) appears in a preceding section of this report designated "Description of Water Supply."

In the past, McAndrews Air Force Base technicians have been responsible for residual chlorine determinations and bacteriological analyses for this water supply. These records have been made available to officials responsible for the potability of the Naval Base water supply.

Records for July and August 1954 were reviewed. During this period, 32 residual chlorine determinations were made on Air Force Base tap water. Approximately 50% of the samples showed 1.0 ppm or more residual chlorine. Roughly 25% of the samples contained between 0.5 and 0.9 ppm chlorine residual. The remaining 25% of the water samples examined showed less than 0.5 ppm residual. Two of the 32 tap water samples contained less than 0.1 ppm residual chlorine. These data are recorded in Table 13, Appendix K. A test for chlorine residual in the tap water at the Naval Station hospital showed 0.3 ppm at 4:15 PM, August 25, 1954.

Bacteriological results for coliform organisms were examined. Beginning July 29, 1954, technicians performing this analytical work used Standard Methods for the Examination of Water and Sewage. Coliform tests were recorded for eight stations July 29, 1954 and for two stations August 25, 1954, all Air Force Base samples. Confirmed tests were recorded as negative for these two sets of samples.

These bacteriological records showed samples from Argentia Pond,

Clarks Pond and Barron Pond during July and August, 1954. Coliform tests for these lake water samples showed gas formers which were confirmed. Attention was invited to the advisability of using only Standard Methods in this bacteriological work and to the need for a greater volume of data as a continuing check on the potability of this water supply.

A considerable number of animal tissue fragments (body cells) were occasionally present in the tap water. The fragments were apparently epithelial tissue from aquatic animals such as fish. The largest number was recorded for October 15, 1954, when the tap water sample sent to Cincinnati for analysis contained over 700 fragments of this tissue per ml and were sufficient in number to cause the water to appear somewhat turbid. If certain people should be allergic to this material, it could constitute a menace to health.

ACKNOWLEDGMENTS

Splendid cooperation was received on this project both in the States and in Newfoundland. Those to whom special thanks are due include:

Bureau of Yards and Docks

A. Eugene Congress
David A. Kendall

Naval Station

Capt. J. S. Tracy (CO)
Cdr. James I. Benson (PWO)
Ch.Mach. A. H. Hurtt (UO)
Lt.Jg. John H. Seitez (MO)
Mrs. Arthur D. Bernstein (TO)
Chief Larkin (Infirmary)

U. S. Central Power Plant

T. J. Fitzpatrick, Qtrman in Charge
Bernard Fitzpatrick, Assistant

Wallace & Tiernan Company, Inc.

George Booth
J. F. Fawls
M. Edwardson

APPENDIX A

DEPARTMENT OF THE NAVY
Bureau of Yards and Docks
Washington 25, D. C.

From: Chief, Bureau of Yards and Docks
To: Surgeon General, Public Health Service, Dept. of Health, Education, and Welfare, Washington 25, D. C.

In reply refer to:
C-3418/jmg
N23
March 1, 1954

Subj: Request for Services to conduct Diatomite Filtration Test for Plankton Removal and to make a Potable Water Survey at NS Argentia

Encl: (1) Dalecarlia Laboratory report dtd 28 Sept. 1953

1. The Bureau desires to engage the Public Health Service to conduct a plankton-removal test and to make a potable water survey at Naval Station, Argentia, Newfoundland.

2. Enclosure (1) is a plankton analysis of a sample of makeup water to the station's central power plant. Prior to softening of this makeup by the sodium zeolite process, it is intended to remove the algae to prevent fouling of the zeolite bed.

3. The Bureau is interested in knowing whether the Public Health Service can make available a sanitary engineer or biologist to conduct a test to determine the feasibility of plankton removal at the power plant by diatomite filtration, and also to make a survey of the source of the station's potable water supply to determine the feasibility of controlling plankton at that point. It is expected that approximately a period of two weeks during April or May 1954 will be required to complete this work.

4. The pilot filter unit will first be set up at the plant of Wallace & Tiernan Company, Newark, N. J. The operation of the unit as set up by this firm must be inspected by your representative before its packaging and shipment to Argentia. Air transportation via military plane from Patuxent, Maryland, will be made available to your representative.

5. Information is desired as to the availability of these services and estimate of cost. Details of the test and survey will be developed when it is known that personnel is available.

J. F. Clarke
By direction

Copy to
DirLant Docks
CO NS Argentia
BuAer SE-5

COPY

28 September 1953

Dalecarlia Laboratory Report

To: Bureau Yards and Docks, Attention Mr. Congress

Thru: Mr. J. C. Smith, Ass't Chief
Water Supply Division, Corps of Engrs. WA

Mr. Byron Bird, Chief
Water Supply Division, Corps of Engrs. WA

Subject: Reply to letter C-241 B/jmg NB/Argentia/N 23 of 26 August '53 Bureau Yards and Docks - Department of Navy. Plankton count - request for.

Sample submitted: - 9/24/53
" analyzed: - 9/24/53

1. 2 - 500 ml. samples submitted from potable water supply at Argentia, Newfoundland. One sample was preserved using 20 ml. formalin/500 ml. water, whereas the other bottle contained no preservative.

2. Sedgwick-Rafter method used to determine plankton content of sample water.

Result (Preserved sample)

Organism	Total 10 random fields counted
TABELLARIA	10
CHROOCOCCUS	500
NAVICULA	1
CYMATO PLEURA	1
ALGAL THREADS	2
	514
Microscope Factor	X7
	3598

3598 plankton organisms found per ml. of sample water. Organisms predominant were Chroococcus and Tabellaria. Count was also made on unpreserved sample but large overgrowth of Chroococcus had occurred so no result is appended.

Following types of plankton organisms found by scanning slide: (very small numbers)

1. Protoccus
2. Aplanospores
3. Dinobryon
4. Fragilaria
5. Aneuria
6. Scenedesmus
7. Navicula

/s/ Norman E. Jackson

N. E. Jackson, Chief

Dalecarlia Section
Operations Branch, Water Supply Div.
Corps of Engineers, Wash. Aqueduct

/s/ John W. Krasauskas

J. W. Krasauskas, Bacteriologist
Corps of Engineers
Wash. Aqueduct

Public Health Service - BSS

SAN-C

March 4, 1954

OIC, Sanitary Engineering Center
Cincinnati, Ohio

Acting Chief, Division of Sanitation

Request from Bureau of Yards and Docks for Services as Indicated on Enclosed Correspondence

The enclosed memorandum has been discussed with the Assistant Chief Sanitary Engineering Officer. He is particularly interested that the Service provide the consultant services requested if at all possible.

It would appear that the problem is one of a basically biological nature but will require some engineering background to properly evaluate the operation of the diatomaceous earth filter.

We would appreciate your advising us at your earliest convenience, as to whether you have available personnel who might be assigned to this study.

Malcolm C. Hope

Enclosure

C
O
P
Y

March 12, 1954

SANITARY ENGINEERING CENTER, CINCINNATI, OHIO

Acting Chief, Div. of Sanitation, BSS

Officer in Charge, SEC

Request from Navy Department for technical service

Reference is made to Mr. Hope's memorandum of March 4, enclosing a request from the Bureau of Yards and Docks, Department of the Navy, for assistance in connection with the water supply at the Naval Station, Argentia, Newfoundland. The Navy Department memorandum is returned herewith.

The Sanitary Engineering Center is prepared to furnish the services of a suitable individual to provide the assistance as requested. The technical services require both biological and engineering knowledge, since two items are involved: 1) determination of the feasibility of plankton removal by diatomite filtration; and 2) determination of the feasibility of controlling plankton growths at the water supply source. Of the two problems involved, the latter is the more complicated technically. We would propose, therefore, to detail Dr. C. M. Palmer of the Biology Section of the Center. Prior to Dr. Palmer's departure for Newfoundland, it is suggested that Mr. Hayse Black accompany him to the Wallace & Tiernan factory for inspection and test operation of filtration equipment to be used.

It should be pointed out that Dr. Palmer is a Civil Service employee. If it is considered essential that a Commissioned Officer be made available, it will be possible to detail Dr. C. M. Tarzwell.

It is suggested that some discussion be held with Navy Department representatives concerning the most appropriate time for scheduling the trip to Newfoundland. Presumably, the trip would be most productive if made after all ice cover has disappeared from the surface source of water supply and there has been some opportunity for the development of plankton growths.

V. G. MacKenzie

Encls.

VGM/hl

SAN:C

March 19, 1954

Commander J. R. Clarke
Chief, Bureau of Yards and Docks
Department of the Navy
Washington 25, D. C.

Re: C-341B/jmg
N23

Dear Commander Clarke:

This will confirm my telephone conversation of March 18 with you and Mr. Berger of your office, and your memorandum of March 1, requesting the Public Health Service to conduct a plankton-removal test and to make a potable water survey in Argentia, Newfoundland.

As I indicated in my telephone conversation, the Public Health Service is happy to furnish you the technical assistance requested, at the convenience of your Command. It is proposed to assign Dr. C. M. Palmer of the Biology Section and Senior Sanitary Engineer H. Black of the Sanitary Engineering Center for the purposes of conducting this survey. The reimbursement to the Public Health Service can be made through the Standard Form 1080 upon the completion of the work.

The following is our estimate of the cost, based on the two week detail of the biologist and approximately one week detail of the sanitary engineer:

Estimate salary costs:

Dr. C. M. Palmer, Biologist, GS-12 $7440 per annum, 2 weeks -	$286.15	
Mr. H. Black, Senior Sanitary Engineer, $9152 per annum, 1 week -	176.00	
Total		$462.15

Estimated travel and per diem costs:

2 persons from Cincinnati, Ohio to Newark, New Jersey, and return -	$350.00	
Grand total		$812.15

Commander J. R. Clarke - 3-19-54

It is understood that the transportation of Dr. Palmer from Patuxent Naval Air Base to Argentia, Newfoundland, will be made by military aircraft.

We are happy to be able to furnish the services of these technicians as requested. Although these officers will be available to conduct this study at your convenience, it is believed that the trip would be most productive if made after all ice cover has disappeared from the surface source of water supply and there has been some opportunity for the development of plankton growths. Included in our proposal is a suggestion that prior to Dr. Palmer's departure for Newfoundland, the engineer, Mr. Black, accompany him to the Wallace & Tiernan factory for inspection and test operation of filtration equipment to be used.

Sincerely yours,

(Sgd) M. C. Hope

Malcolm C. Hope, Acting Chief
Division of Sanitation

CC: OIC, SEC, Cincinnati

DEPARTMENT OF THE NAVY
Bureau of Yards and Docks
Washington 25, D.C.

April 15, 1954

In Reply Refer to:
C-260B/elb
NOy-83983

From: Chief, Bureau of Yards and Docks
To: Department of Health, Education, and Welfare
Public Health Service, Washington 25, D. C.

Attn: Mr. Malcolm C. Hope, Acting Chief, Division of Sanitation

Subj: Plankton Removal Test and Potable Water Survey at Power Plant, Naval Station, Argentia

Ref: (a) Public Health Service ltr SAN:C dtd 19 Mar 54
Fonecon between Bureau and Public Health Service on 1 Apr 54

1. By reference (a) the Public Health Service submitted to the Bureau the estimated salaries and travel costs for Dr. C. M. Palmer, Biologist, and Mr. H. Black, Senior Sanitary Engineer, based on two weeks detail of the biologist and approximately one week of the sanitary engineer to Naval Station, Argentia, at a total cost of $812.15.

2. In confirmation of fonecon, reference (b), it is the understanding of the Bureau that only Mr. H. Black will make the round trip from Cincinnati to the Wallace and Tiernan, Inc. plant in Newark, N. J. to witness the operation of the diatomite filter and equipment prior to its shipment to Argentia. This will reflect an estimated savings of approximately $125 from the total cost as indicated in reference (a), making the total estimated cost to the Bureau $687.15 for the completed survey.

3. Reimbursement for the services of the two Public Health Service men assigned to this project should be made through the standard form 1080 upon completion of the work and will be chargeable to Appropriation 1741201 "Civil Engineering, Navy 1954", Subhead .51, Allotment No. 12527.

4. On 8 April 1954 a representative of the Wallace and Tiernan, Inc. indicated that the diatomite filter and equipment would be ready for a test run on approximately 10 May 1954. The Bureau will keep the Public Health Service informed as to the exact time Mr. H. Black should make the trip to the Wallace and Tiernan plant to witness the operation of the test run of the filter and equipment.

J. F. Clarke
By direction

cc: Wallace & Tiernan, Inc.
Newark, N.J.

APPENDIX B

TABLE 1

Summary of Plankton Analysis of Weekly Tap Water Samples,
Argentia, Newfoundland, May-December 1954

Recorded as number per ml.

Sample No.	Date Collected (1954)	Predominant Algae			All Other Algae	Total Algae	Body Cells*
		Synedra	Dinobryon	Cyclotella			
1	May 14	239	5	0	21	265	
2	June 11	549	0	0	31	580	
3	June 18	593	16	0	44	653	
4	June 25	234	26	0	36	296	
5	July 2	34	377	8	64	483	
6	July 9	18	1037	10	178	1243	
7	July 16	47	1841	16	160	2064	
8	July 23	31	450	29	174	684	
9	July 30	3	88	65	78	244	
10	August 6	0	16	348	44	408	
11	August 13	3	18	1687	276	1984	
12**	August 20	0	0	936	91	1027	0
13	August 27	0	0	403	39	442	0
14	Sept. 3	0	0	637	117	754	156
15	Sept. 10	0	0	1885	338	2223	0
16	Sept. 17	0	0	520	26	546	26
17	Sept. 24	0	0	481	247	728	0
18	Oct. 1	0	52	429	221	702	0
19	Oct. 8	0	39	507	208	754	26
20	Oct. 15	13	39	637	195	884	715
21	Oct. 22	0	13	507	117	637	39
22	Oct. 29	0	26	247	169	442	0
23	Nov. 5	0	0	117	140	260	0
24	Nov. 12	13	13	221	351	598	0
25	Nov. 19	0	0	104	156	260	0
26	Nov. 26	0	0	91	273	364	0
27	Dec. 3	0	13	143	598	754	0
28	Dec.10	0	0	143	65	208	0
29	Dec.17	0	0	13	39	52	0
30	Dec.24	13	0	26	91	130	0

* These are epithelial cells, probably from slime coating of fish or other aquatic life.

** Sample analyzed at Argentia, also reported in Table 2, Appendix C, (8:45 A.M. Sample, August 20).

APPENDIX C
TABLE 2
SUMMARY OF
PLANKTON ANALYSIS* OF TAP WATER SAMPLES
NAVAL STATION, ARGENTIA, NEWFOUNDLAND

		Cyclotella	All Other Algae	Total Algae	Mold Spores	Body Cells	Amorphous Particles	Total Matter
Fri. 8/20	8:45 AM	72	7	79	0	0	10	89
	9:45 AM	52	10	62	0	0	12	74
	12:45 PM	45	2	47	2	1	7	57
	3:45 PM	25	2	27	2	0	10	39
	9:15 PM	39	1	40	0	0	8	48
Sat. 8/21	8:45 AM	25	1	26	2	3	15	46
Hydrants	9:00 AM	20	1	21	2	2	5	30
flushed	9:30 AM	209	13	222	5	1	56	284
9:05 AM	9:45 AM	300	13	313	45	0	85	443
	10:00 AM	190	15	205	15	0	44	264
	10:15 AM	169	7	176	10	0	29	215
	12:15 PM	125	2	127	8	0	6	141
	12:30 PM	85	6	91	13	21	31	156
	5:30 PM	34	2	36	2	0	5	43
Sun. 8/22	9:30 AM	31	1	32	4	0	15	51
	2:00 PM	25	1	26	2	0	13	41
Mon. 8/23	8:15 AM	41	1	42	3	0	57	102
Hydrants	9:45 AM	146	9	155	10	94	12	271
flushed	10:00 AM	117	11	128	11	51	26	216
9:15 AM	10:15 AM	132	7	139	30	6	16	191
	10:30 AM	126	6	132	17	1	7	157
	10:45 AM	129	3	132	24	2	34	192
	11:00 AM	149	6	155	9	0	19	183
	11:15 AM	184	6	190	44	0	17	251
	12:00 Noon	115	6	121	16	0	9	146
	3:00 PM	24	1	25	4	0	11	40
	5:00 PM	34	0	34	6	1	5	46
	8:10 PM	44	2	46	7	0	18	71
Tues.8/24	8:15 AM	37	0	37	11	0	13	61
Hydrants	8:45 AM	53	0	53	0	0	2	55
flushed	9:25 AM	73	1	74	12	0	11	97
8:50 AM	10:30 AM	73	1	74	5	0	5	84
10:35 AM	10:45 AM	193	5	198	10	0	6	214
12:35 PM	11:00 AM	147	8	155	11	1	14	181
2:55 PM	11:45 AM	77	1	78	7	0	20	105
	12:30 PM	0	0	0	0	2	12	14

(Continued)

Table 2 (Continued)

		Cyclotella	All Other Algae	Total Algae	Mold Spores	Body Cells	Amorphous Particles	Total Matter
Tues. 8/24	1:10 PM	15	1	16	1	1	13	31
	1:30 PM	1	0	1	0	0	5	6
	2:00 PM	1	0	1	2	0	4	7
	2:50 PM	0	0	0	1	0	10	11
	3:15 PM	41	1	42	5	0	47	94
	5:00 PM	0	0	0	3	0	19	22
	7:30 PM	61	3	64	10	0	8	82
Wed. 8/25	8:15 AM	72	1	73	10	0	4	87
	8:50 AM	60	10	70	10	0	9	89
	10:30 AM	54	0	54	9	1	23	87
	11:30 AM	53	2	55	7	0	29	91
	12:30 PM	31	3	34	4	0	32	70
	1:10 PM	1	0	1	3	0	9	13
	1:30 PM	43	3	46	10	2	14	72
	2:30 PM	63	5	68	9	0	19	96
	3:30 PM	78	3	81	12	0	16	109
	4:30 PM	67	4	71	4	1	6	82
Thurs.8/26	8:15 AM	53	6	59	6	0	25	90
	3:00 PM	48	7	55	0	1	19	75
Fri. 8/27	8:45 AM	41	8	49	10	1	6	66
Sat. 8/28	10:45 AM	27	2	29	8	0	9	46
Sun. 8/29	2:00 PM	43	5	48	5	0	3	56
Mon. 8/30	7:15 PM	38	9	47	20	0	2	69
Tues. 8/31	8:30 AM	41	13	54	34	0	28	116
Average		71	4	978	8.8	3.2	17	104

* Recorded as direct strip counts.
To obtain number per ml., multiply by 13

APPENDIX D

TABLE 3

Identification of Algae

Genera of Algae Recorded for Argentia Tap Water, Clarks Pond, and City of St. Johns Tap Water. May-December 1954

	Argentia Tap Water			Clarks Pond	St.Johns Tap Water
	May-Aug.19	Aug.20-31	Sept.-Dec.	Aug. 24-25	Aug. 22
DIATOMS					
Asterionella	x	x	x	x	
Cyclotella	x	x	x	x	x
Cymbella		x		x	x
Fragilaria				x	
Gomphonema	x	x		x	
Melosira			x		
Navicula	x	x	x	x	
Nitzschia		x			
Surirella	x	x			
Synedra	x	x	x	x	x
Tabellaria	x	x	x	x	
GREEN ALGAE					
Ankistrodesmus	x				
Bulbochaete				x	
Chlorella	x	x	x	x	
Chlorobotrys	x	x			
Coelastrum		x			x
Cosmarium		x			
Crucigenia				x	
Dictyosphaerium				x	
Elactothrix		x			
Golenkinia		x			
Gonatozyon		x			
Hyalotheca		x			
Mougeotia				x	
Oedogonium		x		x	
Oocystis		x	x	x	
Scenedesmus			x		
Spirogyra		x			
Staurastrum	x	x	x	x	
Stigeoclonium				x	
Zoochlorella				x	

APPENDIX D Page 2 Cont'd

TABLE 3

Identification of Algae

Genera of Algae Recorded for Argentia Tap Water, Clarks Pond, and City of St. Johns Tap Water. May-December 1954

	NS Argentia Tap Water			Clarks Pond	St.Johns Tap Water
	May-Aug.19	Aug.20-31	Sept.-Dec.	Aug. 24-25	Aug. 22
BLUE-GREEN ALGAE					
Anabaena				x	
Calothrix				x	
Chroococcus	x	x	x	x	x
Gloeocapsa	x	x	x	x	x
Gloeothece	x		x		
Gomphosphaeria					x
Merismopedia		x	x		x
Microcystis					x
Oscillatoria	x		x		
Rhabdoderma		x	x		x
Stigonema				x	
PIGMENTED FLAGELLATES					
Ceratium		x		x	
Chlamydomonas	x	x			
Chromulina	x	x	x	x	x
Chrysococcus	x	x	x		
Cryptomonas	x	x	x	x	
Dinobryon	x	x	x		x
Euglena	x	x			
Gymnodinium	x				
Mallomonas	x			x	
Peridinium	x	x	x	x	
Phacotus			x		
Phacus	x				
Trachelomonas	x		x		

APPENDIX B
TABLE 4

DIATOMITE FILTER STUDIES
SLURRY CONCENTRATION 1.965 POUNDS PER GALLON
NAVAL STATION, ARGENTIA, NEWFOUNDLAND
AUGUST 1954

Date August 1954	Run No.	End of Run Filter Bottom Pressure psi	Body Feed Dial Setting	Filter Aid Used Pounds	Body Feed G.P.H.	Filter Rate G.P.M.	Length of Run		Economy Gallons Filtered Per Pound Filter Aid
							Hrs.	Min.	
20	1	7.5	0	1	0	27	1	10	1890
20	2	16	2	3.76	0.136	27.9	10	20	4600
21	3	5	2	1.70	0.133	26.9	2	50	2700
21	4	21	4	6.18	0.484	28.2	5	45	1580
22	5	26	3	3.62	0.320	28.1	4	25	2060

APPENDIX B
TABLE 5
DIATOMITE FILTER STUDIES
SLURRY CONCENTRATION 1.5 POUNDS PER GALLON
NAVAL STATION, ARGENTIA, NEWFOUNDLAND
AUGUST 1954

Date August 1954	Run No.	End of Run Filter Bottom Pressure psi	Body Feed Dial Setting	Filter Aid Used Pounds	Body Feed G.P.H.	Filter Rate G.P.M.	Length of Run Hrs.	Length of Run Min.	Economy Gallons Filtered Per Pound Filter Aid
23	6	6	3	8.05	0.428	27.4	11	0	2250
24	7	8.5	2.5	6.35	0.275	27.6	13	0	3390
25	8	8	< 2	3.73	-	27.1	14	0	6115
25-26	9	16.5	< 2	2.64	-	27.2	8	25	5190*
26	10	23	2	-	-	26.9	10	50	-

* Computed on Basis No.8 Filter Run

APPENDIX B
TABLE 6
DIATOMITE FILTER STUDIES
LENGTH OF FILTER RUNS AND WATER GAUGE READINGS
NAVAL STATION, ARGENTIA, NEWFOUNDLAND
AUGUST 1954

Date August 1954	Run No.	Line Pressure psi		Reduced Pressure psi		Filter Top Pressure psi		Filter Bottom Pressure psi		Length of Run	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Hrs.	Min.
20	1*	-	-	-	-	32	32	32	7.5	1	10
20	2	65	58	37	36	32	31	31.5	16.	10	20
21	3	80	62	37	36	32.5	31.5	30.5	5	2	50
21	4	67	60	37	37	31.5	31.5	30	21	5	45
22	5	68	62	38	37	31.5	31	31	26	4	25
23	6	70	52	38	35	32	30	31	6	11	0
24	7	90	46	39	31	34	30	32	8.5	13	0
25	8	67	55	37	35	32	30	30	8	14	0
25-26	9	70	65	30	30	25	24.5	24	16.5	8	25
26	10	67	55	35	27	30	29	28	23	10	50

* Precoat only

APPENDIX E

TABLE 7

DIATOMITE FILTER STUDIES

FILTER AID ECONOMY RELATED TO PLANKTON AND TOTAL MATTER

NAVAL STATION, ARGENTIA, NEWFOUNDLAND

AUGUST 1954

Filter Run No.	Body Feed Dial Setting	Length of Run Hours	End of Run Filter Bottom Pressure psi	Economy Gallons Filtered per pound Filter Aid	Total Algae per ml.			Total Matter per ml.		
					Maximum	Minimum	Average	Maximum	Minimum	Average
1	0	1.17	7.5	1890	1014	806	910	1144	962	1053
2	2	10.33	16	4600	611	351	494	741	507	624
3	2	2.83	5	2700	4069	1651	2712	5739	1833	3502
4	4	5.75	21	1580	1183	468	826	2028	559	1294
5	3	4.42	26	2060	416	338	377	663	533	598
6	3	11	6	2250	2470	325	1487	3523	498	2075
7	2.5	13	8.5	3390	2574	0	687	2782	78	929
8	<2.	14	8	6115	1014	13	699	1417	169	1035
9	<2.	8.42	16.5	5190	767	715	741	1170	975	1073

APPENDIX F
TABLE 8
COMPARISON OF PLANKTON IN TAP WATER AND FILTERED WATER
NAVAL STATION, ARGENTIA, NEWFOUNDLAND
AUGUST 1954

Date	Hour	Filter Run No.	TAP WATER							FILTERED WATER						
			Cyclotella	All Other Algae	Total Algae	Mold Spores	Body Cells	Amorphous Particles	Total Matter	Cyclotella	All Other Algae	Total Algae	Mold Spores	Body Cells	Amorphous Particles	Total Matter
Fri. 8/20	9:45 AM	1	52	10	62	0	0	12	74	2	0	2	0	0	25	27
Fri. 8/20	12:45 PM	2	45	2	47	2	1	7	57	0	0	0	3	2	4	9
	3:45 PM	2	25	2	27	2	0	10	39	0	0	0	6	2	37	45
Sat. 8/21	9:45 AM	3	300	13	313	45	0	85	443	0	0	0	0	0	5	5
	12:15 PM	3	125	2	127	8	0	6	141	0	0	0	1	0	1	2
Mon. 8/23	10:15 AM	6	132	7	139	30	6	16	191	0	0	0	0	0	9	9
	8:10 PM	6	44	2	46	7	0	18	71	0	0	0	0	0	5	5
Tue. 8/24	10:45 AM	7	193	8	201	10	0	6	217	0	1	1	3	0	38	42
	2:00 PM	7	1	0	1	2	0	4	7							
	2:30 PM	7								0	0	0	0	0	19	19
Wed. 8/25	4:30 PM	8	67	4	71	4	1	6	82							
	10:30 PM	8								0	0	0	2	0	11	13
Thu. 8/26	3:00 PM	10	48	7	55	0	1	19	75	0	1	1	0	0	13	14
Average per sample			94	5	99	10	1	17	127	0	0	0	1	0	17	19

Results given in direct strip counts
To obtain number per ml., multiply by 13

APPENDIX G
TABLE 9
COAGULATION STUDIES FOR PLANKTON REMOVAL
NAVAL STATION, ARGENTIA, NEWFOUNDLAND
AUGUST 1954

Test No.	Date August 1954	Time	pH Raw Water	pH Treated Water	Lime Dosage Grains/gal.	Alum Dosage Grains/gal.	Description of Floc	Raw Water Total Algae per ml.	Treated Water Total Algae per ml.
1	24	9:45 AM	6.2	6.4	1	2	Very good	962	0
2	24	1:00 PM	6.5	6.8+	1	1.5	Poor	208	481
3	24	3:15 PM	6.5	6.6	1	2	Very good	546	13
4	25	8:50 AM	6.2	6.8	0.5	1	Poor	910	494
5	25	4:40 PM	6.3	6.8+	1	2	Good	754	65

Note: Stirred gently for 20 minutes following addition of chemicals.
Treated water samples were collected one hour and forty minutes after stirring was stopped.

APPENDIX H

TABLE 10

COMPARISON OF PLANKTON IN TAP WATER AND COAGULATED WATER

NAVAL STATION, ARGENTIA, NEWFOUNDLAND

AUGUST, 1954

Date	Hour	Test No.	Tap Water							Coagulated Water						
			Cyclotella	All Other Algae	Total Algae	Mold Spores	Body Cells	Amorphous Particles	Total Matter	Cyclotella	All Other Algae	Total Algae	Mold Spores	Body Cells	Amorphous Particles	Total Matter
Tues. 8/24	9:25 AM 11:45 AM	1	73	1	74	12	0	11	97	0	0	0	0	14	18	32
Tues. 8/24	1:10 PM 3:00 PM	2 2	15	1	16	1	1	13	32	32	5	37	16	0	163	216
Tues. 8/24	3:15 PM 5:15 PM	3 3	41	1	42	5	0	47	94	1	0	1	2	0	94	97
Wed. 8/25	8:50 AM 11:00 AM	4 4	60	10	70	10	0	9	89	37	1	38	1	1	89	129
Wed. 8/25	4:25 PM 6:40 PM	5 5	56	2	58	9	0	30	97	1	4	5	5	1	35	46
Average			49	3	52	7	0	22	82							

Results given in Direct, Strip Counts.

To obtain number per ml., multiply counts by 13.

APPENDIX I

TABLE II

NUMBER OF PLANKTON ORGANISMS IN ARGENTIA WATER SOURCE PONDS
NAVAL STATION, ARGENTIA, NEWFOUNDLAND
AUGUST 24, 1954

	Cyclotella	All Other Algae	Total Algae
Gull Pond	1	4	5
Kidney Pond	0	0	0
Barror Pond	1	9	10
Clarks Pond	21	3	24
Argentia Pond	7	5	12
Non-Argentia Waters, for Comparison:			
Larkins Pond 8/24/54	12	7	19
Pond 20 miles east of Argentia 8/30/54	4	3	7
St. Johns, Newfoundland Tap Water 8/22/54 9:30 A.M.	0	4	4

Results given in Direct, Strip Counts.

To obtain number of organisms per ml, multiply strip counts by 13.

APPENDIX J

TABLE 12

NUMBER OF PLANKTON ORGANISMS AT THREE LOCATIONS IN CLARKS POND
NAVAL STATION, ARGENTIA, NEWFOUNDLAND
AUGUST 1954

	Cyclotella	All Other Algae	Total Algae	Mold Spores	Body Cells	Protozoa	Pollen Grains	Amorphous Particles	Total Matter
nter of Pond 8/23/54	21	3	24	0	0	2	0	0	26
ore line near intake 8/24/54	24	3	27	6	0	0	0	99	132
take well at creens 8/24/54	33	10	43	9	1	1	1	201	256

sults given in Direct, Strip Counts.

obtain number per ml., multiply by 13.

APPENDIX K

TABLE 13

SUMMARY OF RECORDS SHOWING PPM RESIDUAL CHLORINE IN 32 TAP WATER SAMPLES OBTAINED FROM VARIOUS ARGENTIA, NEWFOUNDLAND AIR FORCE BUILDINGS DURING JULY-AUGUST 1954

P.P.M. Residual Chlorine	No. of Water Samples Recorded for Each Residual
0.0	0
0.1	2
0.2	2
0.3	2
0.4	1
0.5	0
0.6	2
0.7	1
0.8	5
0.9	0
1.0	16
1.1	0
1.2	1